USDA Forest Service Technical Assistance Trip Report

Wami River Sub-Basin Wetland Assessment and Training

Mission Dates: June 15 -29, 2009

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ACKNOWLEDGEMENTS

We would like to thank the Tanzanian Coastal Management Partnership (TCMP), the University of Rhode Island's Coastal Resources Center (CRC), and the Wami-Ruvu Basin Water Office (WRBWO) for their planning and logistical support throughout this mission. Special thanks to Misigalo Kigadye (WRBWO) for his guidance, hospitality, humor, and all around good nature; and to Jacob Mlula (TCMP) for his long hours of driving, flexibility, and keeping the team on track. We would specifically like to thank James Tobey of CRC for his upfront organization of mission details, as well as Appa Mandari (TCMP), and Julius Sarmett (WRBWO) for their support throughout. We also express our gratitude for the time and expertise lent to us by the Rangers and Wardens of Saadani National Park (SANAPA), particularly that of Park Ecologist, Halima Ramadhani. We extend our thanks to the attendees of the workshop for their attentiveness, patience and invaluable feedback during the classroom and field sessions. And finally, we'd like to recognize Richard Kramer (District Ranger, Sandpoint, ID) and Bob Davis (Director for Planning and Water, Soil and Air, Albuquerque, NM) of the USDA Forest Service for grasping the value of the program and allowing us the resources and time away from our primary duties to assist in this technical mission.
Our sincere thanks,

Jason Gritzner, Hydrologist
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August 17, 2009

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LIST OF ACRONYMS

CRC	Coastal Resources Center
EFA	Environmental Flows Assessment
FAO	Food and Agriculture Organization
GDA	Global Development Alliance
GIS	Geographic Information System
GPS	Geographic Positioning System
IUCN	International Union for Conservation of Nature
NAWAPO	National Water Policy
MNRT	Ministry of Natural Resources and Tourism
NAWESCO	National Wetlands Steering Committee
NEMC	National Environment Management Council
NGO	Non Governmental Organization
NWWG	National Wetlands Working Group
SANAPA	Saadani National Park
SUCCESS	Sustainable Coastal Communities and Ecosystems
TANAPA	Tanzania National Parks
TCMP	Tanzania Coastal Management Partnership
TWRI	Tanzania Wildlife Research Institute
URI	University of Rhode Island
USACOE	United States Army Corps of Engineers
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USFS IP	United States Forest Service International Programs
WRBWO	Wami-Ruvu Basin Office
WWF	World Wildlife Fund

EXECUTIVE SUMMARY

The USFS technical resource team, composed of Jason Gritzner and Roy Jemison, visited the Wami River Sub-basin and Saadani National Park areas from June 15 through 29, 2009. Findings from the field portion of this mission identified a relationship between the intensity of land-use, industry, water abstraction, and resource extraction on the functioning condition of wetland-riparian areas.

Agricultural practices in the riparian areas of the Wami, Mkindo, and Diwale Rivers and riverine wetlands of the Tami and Divue Rivers, as well as the Msagere and Tubilinyi Kwajumbe wetland all render the functioning condition of these wetland-riparian areas as functioning at risk. Land conversion, water abstractions, and pollution are identified as the leading threats.

Grazing in the north-central part of the sub-basin, in the Kinyasungwe River area, was the leading land-use threatening riparian areas through the trampling and heavy browsing of herbaceous plants along the banks of ephemeral channels. Although much of the Kinyasungwe system was identified as a wetland, only a portion near Gode Gode exhibited wetland characteristics. Vegetation in this wetland was dominated by *tamarisk sp* with pockets of obligate wetland species. Other than the dominance of a potentially non-native facultative species, the wetland was in properly functioning physical condition. Grazing is also occurring through much of the Mkata Plain and is assumed to be affecting wetland-riparian areas to some extent.

Wetlands that were most affected by anthropogenic activities were those drained or excavated for industrial purposes, and those used for the production of bricks. The Msanvu Nzambarnuni wetland complex along the Morogoro River was rendered non-functioning in areas of brick production and where wetlands were trenched to provide for the installation of infrastructure and development. The salt works near the estuary of the Wami River has also rendered a large portion of the mangrove non-functioning.

Wetland-riparian areas within Saadani National Park were properly functioning.

The hydrologic services provided by wetlands in the Wami River Sub-basin aid in the attenuation of flood flow, filter sediment and pollutants, facilitate groundwater recharge, and meter surface flows to the Wami River system later into the dry season. Although the hydrologic connection of wetlands to the Wami River is broadly understood, it is unknown to what extent the compromised functioning condition of wetlands is currently affecting flows in the Wami River and its related ecosystems.

In general, assessing the extent and conditions of wetlands was complicated by the lack of available aerial photography for the area. Other challenges included inaccuracies in areas currently identified as wetlands, both in extent, and classification. With little to no data available for wetlands, a departure from baseline conditions cannot be identified, nor can current trends in resource conditions be known. These issues are identified as

challenges that will need to be overcome for the effective management of wetlands in the sub-basin.

The workshop component of the mission provided participants with an introduction to wetlands, inventory and monitoring protocol, and practical experience in using the Proper Functioning Condition (PFC) protocol, as well as facilitated discussion regarding agency jurisdiction and environmental law. The format of the course included two days of classroom presentations, followed by a day in the field for the participants to use the assessment tools presented during the previous days. Participants indicated that information presented during the course will prove very useful. The workshop is considered an initial step in creating the capacity needed for the effective management of wetland-riparian resources.

Overall, there is an urgent need for agencies and organizations that work in and around the Wami Basin to gain a better understanding of their wetland resources and how to manage them sustainably. This cannot and should not be attempted alone or piecemeal. An informed, collaborative effort should be undertaken as they move forward. A start could be to determine the status of the National Wetland Working Group and what resources they may have to offer. Brief internet research shows there to be documented management and many uses of Tanzania's vast water resources. The task of assembling this information to make it useable and widely available would contribute greatly to this effort.

It is our sincere hope that the contributions of past, present and future USFS technical assistance missions will help management agencies and organizations develop a better understanding of their wetland and water resources.

INTRODUCTION: SCOPE OF TECHNICAL ASSISTANCE

As discussed in the previous technical assistance report (Gritzner and Sumerlin 2007), the US Forest Service International Programs (USFS IP), within the Department of Agriculture (USDA), has a long history of promoting sustainable forest management and the conservation of biodiversity in Africa. USFS IP provides targeted technical assistance by working in collaboration with host-country government forest and natural resource management institutions, the US Agency for International Development (USAID), and local and international nongovernmental organizations (NGOs). In Africa, the USFS has linked the skills of its field-based staff with partners overseas in over 20 countries, providing assistance on a wide variety of topics, including sustainable use of forest resources, fire prevention and suppression, information management, landscape-scale land use planning, watershed management, protected area management, and institutional strengthening and reform.

In Tanzania, the USFS IP is an implementing partner to USAID/Tanzania's Natural Resources Management program, which aims to conserve biodiversity in targeted landscapes through a livelihood driven approach. The role of the USFS in this program is as a provider of targeted technical and capacity building assistance aimed at supporting lead implementing NGOs and government partners on each of the landscapes to improve natural resource management (Gritzner and Sumerlin 2007).

One of the four focal landscapes for USAID under this program is the Coastal ecosystem, on which the Tanzania Coastal Management Partnership (TCMP) is the lead implementing partner. On this landscape TCMP is pioneering a Landscape to Seascape approach to conservation. This landscape falls within the Pangani and Bagamoyo districts, and includes the Wami River Basin and its estuary, along with Saadani National Park (SANAPA), East Africa's only combined terrestrial and coastal park. TCMP is a joint initiative between the National Environment Management Council (a Tanzanian Government office), the University of Rhode Island's Coastal Resources Center and USAID (Gritzner and Sumerlin 2007).

Since 2006, USAID has supported projects coordinated by the Tanzania-SUCCESS project of the University of Rhode Island/Coastal Resources Center. During this time, a Wami River sub-basin profile was written, an Environmental Flow Assessment was produced, two assessments of the Wami estuary have been conducted, and an assessment of the linkages among the lower Wami and Saadani National Park was completed – all in contribution to ongoing and future conservation initiatives in the Wami River sub-basin.

Although much has been learned about watershed resources in the Wami River sub-basin through these and other investigations, little detailed study of wetlands has occurred in the area. This has surfaced as an issue as the degradation of water quality and quantity continues to threaten biodiversity and livelihood strategies. Wetlands are widely recognized as performing a range of services from improving water quality, recharging aquifers, and metering the release of surface waters during the dry season, to attenuating peak flows or floods, providing wildlife habitat, and cultural resources. As the

documented use and degradation of wetlands in the Wami River sub-basin continues, so does the threat to water resources throughout the region.

Because wetland health and function is important to the quality of a broad array of physical, biological, cultural, and economic resources, and it is acknowledged that the extent and classification of wetlands is not well documented, TCMP identified a need to initiate broad scale, rapid assessment of wetlands in the Wami River sub-basin, and to begin training local professionals in wetland inventory and monitoring techniques. To accomplish this task, TCMP engaged USFS IP for technical assistance. The USFS team that was assembled for this investigation consisted of Jason Gritzner (Hydrologist, Idaho Panhandle National Forests) and Dr. Roy Jemison (Hydrologist, Southwest Regional Headquarters).

The specific objectives for this USFS mission to the Wami River sub-basin were to:

- Delineate wetlands and their biodiversity in the Wami sub-basin with a focus on palustrine wetlands
- Establish relationship in hydrology of the wetlands and the main Wami River
- Identify wetland condition and threats
- Build capacities of Wami sub-basin stakeholders in monitoring and sustainable management of wetlands
- Identify options and priorities for improved wetland conservation and sustainable use

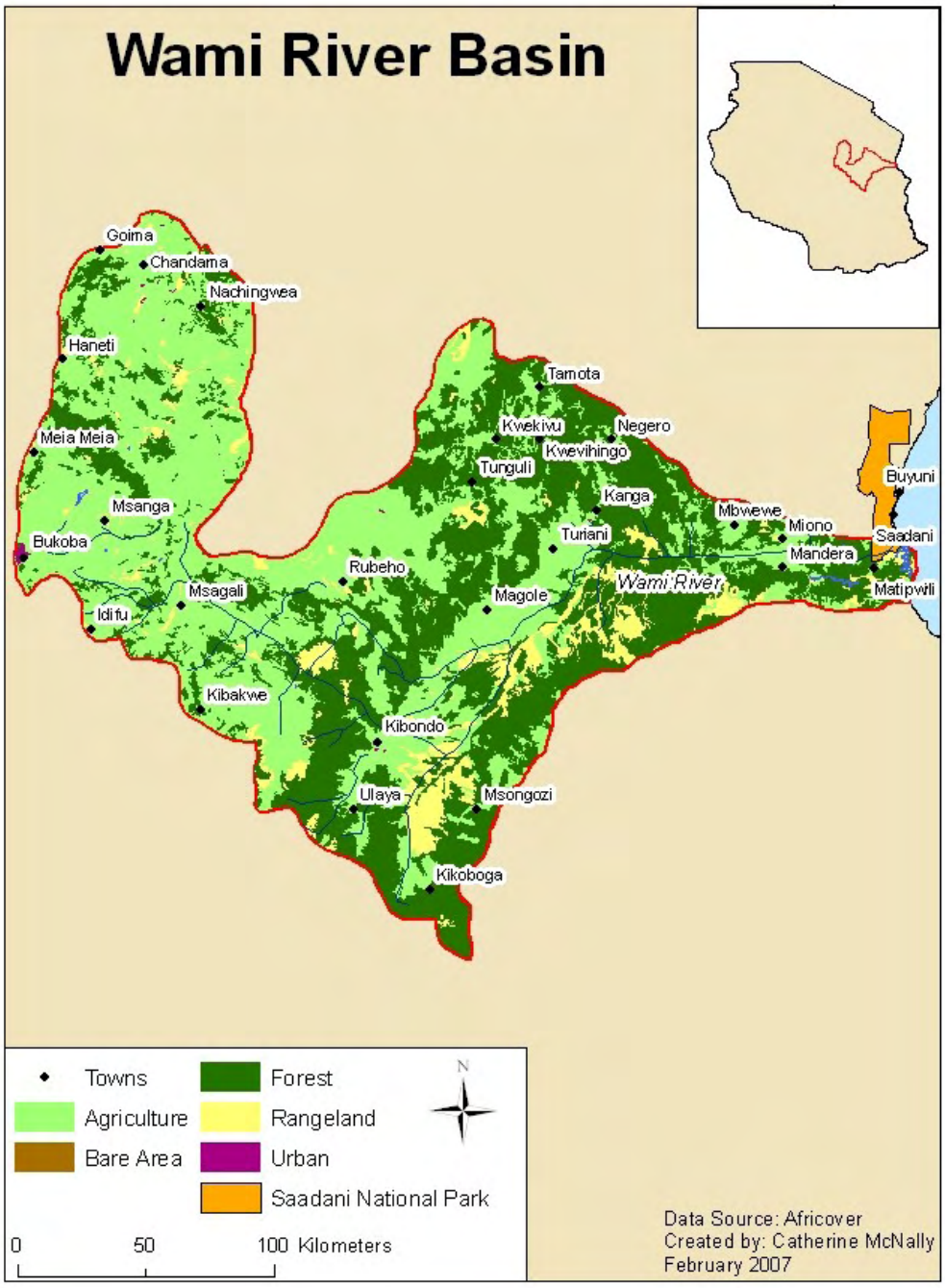

Figure 1. Locator and land-use map for the Wami River basin and Saadani National Park (Gritzner and Sumerlin 2007).

1. Background and Context

The geography and climate of the Wami River sub-basin (Figure 1), its protected areas, and biodiversity are described in the initial 2007 technical report (Gritzner and Sumerlin 2007). In that report, it is stated that as a result of drought over the last four years, the flow of the Wami River has noticeably diminished in both the wet and dry seasons (Gritzner and Sumerlin 2007). This condition continues in 2009. There were anecdotal reports of very little rain falling during the recent rainy season, and lower water levels were observed in rivers and wetlands. The 2007 report expresses concern over the expanding water extraction from the Wami River system for agricultural purposes (i.e Mtibwa Sugar Factory and Dkawa rice project) and municipal use (Chalinze Water Supply Project) and the threat it poses to ecosystems, biodiversity and livelihood strategies, especially when combined with extended drought conditions (Gritzner and Sumerlin 2007). This situation also continues in 2009 with proposals to install a sugarcane plantation near Matipwili (Valimba 2007) and expand the municipal water system for Dar Es Salaam using Wami River water.

In 2002, under new National Water Policy (NAWAPO), the environment was granted second priority to that of adequate quantify and quality of water for basic human needs (EFA 2008). In 2007, an Environmental Flow Assessments (EFA) was completed for the Wami River sub-basin that assessed the minimum flow required to maintain environmental conditions at different points within the sub-basin during different times of year (EFA 2008). This assessment provides the Wami-Ruvu Basin Water Office (WRBWO) the quantitative information needed to manage water extractions for human use while continuing to maintain the physical and biological integrity of the Wami River system to provide for ecosystem function, biodiversity, and basic socio-economic values. This EFA is a critical step in defining management criteria in the Wami River sub-basin.

However, another critical element to understanding the mechanisms that control hydrologic flows in the Wami is wetlands. This is a component that the EFA and other studies have not focused on in detail. The extent, type, and functioning condition of wetlands will be an important component of the hydrologic system in the Wami River sub-basin to understand, not only for its effect on regulating downstream flows and improving water quality, but for their inherent contribution to a functioning landscape that supports and regulates physical processes, ecosystems, biodiversity, and the socio-economic requirement of its human inhabitants. Ultimately, the successful management of this resource will be critical to realizing conservation objectives.

1.1 Summary of Existing Condition for Wetlands

In the Wami River sub-basin (Figure 1) there are a variety of wetlands types. Depending on the preferred naming convention, these include riverine, palustrine, lacustrine, and estuarine, as identified in the scope of work for this assignment (Cowardin et al. 1979). Within these groups of wetlands, further classification can occur based on physical or biological parameters. Although no suggestion is being made in this report as to which classification scheme should be used, based on Cowardin classification system, the

wetlands that we observed during this rapid assessment included riverine, lacustrine, and palustrine wetland types throughout the sub-basin, with estuarine wetlands occurring on or near the coast. Wetland classification will be discussed in greater detail later in the report.

The condition of wetlands in the Wami River sub-basin varies widely, with the greatest variable affecting the functioning condition of wetlands being human use. In protected areas such as Saadani National Park and the Zaraninge Forest where human use of natural resources is restricted, wetlands are predominantly functioning properly. Repeat investigations in 2009 of Lake Kiwandi (or Kiwandi Swamp) show some reduced water content owing in part to seasonal variability, as well as extended drought conditions, but there is no marked change in vegetation or evidence of diminished function (Figure 2).

Figure 2. Lake Kiwandi in 2007 (left) and 2009 (right)

Riparian, or riverine wetlands within protected areas are also in functioning condition with minor evidence of disturbance in areas being developed for camps in the park near the river (Figure 3).


Figure 3. Riparian area of Wami River in Saadani National Park.

Msagere and Tubilinye Kwajumbe wetlands are located in the Zaraninge area and are formed by the road crossing surface-water drainage features. Culverts through the road are perched in the fill, causing a back-water, which over time develops wetland attributes. Our 2009 observations showed water levels down to more residual levels compared to 2007 observations. Although water levels do normally decrease during the dry season in these wetlands, water levels were said to be much lower than normal for this time of year as a result of decreased precipitation (Figure 4). With some increased agricultural land use in areas adjacent to the wetland, they may be considered to be functioning at risk.

Figure 4. Tubilinye Kwajumbe wetland in 2007 (top) and 2009 (bottom).

In other parts of the Wami River sub-basin that were not visited in 2007, most wetlands the team observed were subjected to some level of direct human use or effects of adjacent land-use. Despite these effects, such places as the papyrus wetland fed by the Divue River, and the Kinyasungwe near Gode Gode, were functioning, albeit at some level of risk. The Msanvu Nzambarnuni wetland in the flood plain of the Morogoro River (Figure

5) and others such as those that are being exploited for brick making are barely functioning, or non-functional.

Figure 5. Msanvu Nzambarnuni wetland is being exploited for brick making. The wetland is considered to be functioning at great risk on a trend toward non-functioning.

We also investigated other areas that were delineated as wetlands in the GIS database at the WRBWO. Parts of the Kinyasungwe and Pandambiri that were delineated as wetlands do not contain the soil properties, hydrology, or plant species that are normally used to classify an area as a wetland, and so, cannot be classified as a wetland. These areas are periodically inundated, but do not remain saturated for a long enough period of time to develop anaerobic soil properties, or obligate/facultative wetlands.

2. ISSUES, FINDINGS, CONCERNS AND RECOMMENDATIONS

The USFS team's mission in the Wami River sub-basin from June 15-29, 2009, was focused on wetland resources. Approximately half this time was spent in the field getting a broad overview of wetland systems within the sub-basin, while the other half was spent preparing for and conducting a wetlands workshop that provided an overview of wetland resources and an introduction to inventory and monitoring techniques. Both phases of the mission provided opportunities to identify challenges in managing wetland resources to maintain function, positively affect water resources, and support biodiversity in the greater sub-basin. Information on these issues specific to the Wami River sub-basin was gathered through field investigations of wetlands and riparian areas; meetings and discussions with national park officials, governmental and non-governmental natural resources management agencies, and individual community members; as well as data and previous investigation into water resources within the sub-basin.

Wetlands in their functional state are widely recognized to provide a great number of ecosystem services (Leonard et al. 1997, Windell et al. 1986). Besides providing cultural resources that include water, food (vegetable and protein), medicine, and building materials, wetlands also purify surface water, trap sediment, attenuate flood waters, function as points of both groundwater recharge and discharge, and are able to meter surface flows of water well into or through dry periods when water is scarce. Wetlands are also recognized as being some of the most biologically diverse places on earth (Windell et al. 1986).

Threats to wetlands are numerous. Because of what wetlands are both in a physical and biological sense, they are inherently useful in terms of providing the raw materials needed to support basic livelihood strategies, and can be prone to overexploitation. Paradoxically, in their functional state, they are also sometimes viewed as wastelands – an impediment to productive land use and a source of disease, and are purposefully converted to other land cover types. The thoughtful management of wetlands is a critical component of successfully meeting a wide range of conservation and management objectives including the management of water resources, biodiversity, health and welfare, and livelihood strategies.

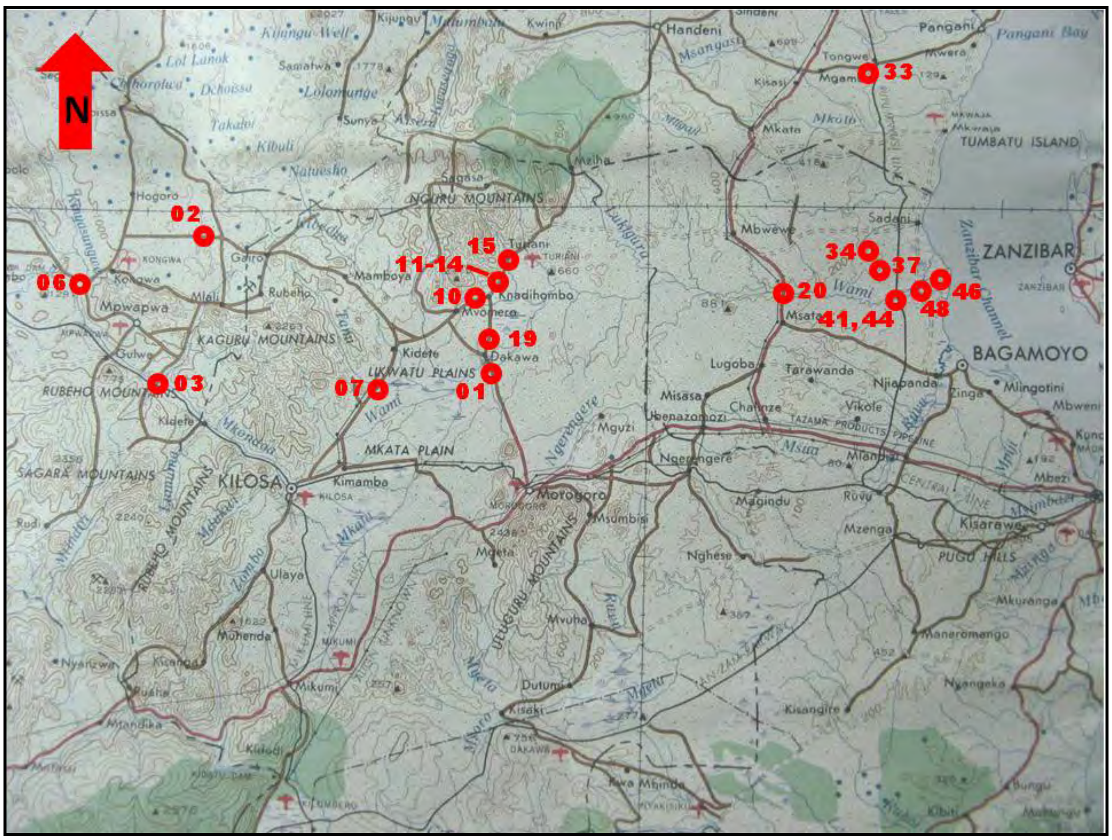

Figure 6. Map with waypoint depicting sites visited. Table with description of way points in Appendix G.

2.1 Effects of Agriculture on Wetlands

Findings and Concerns: Agriculture is the most abundant land use/land cover type in the Wami River sub-basin (Figure1). Productivity in agricultural systems relies on the presence of water and soil nutrients. For this reason wetlands are inherently useful for agricultural purposes. During our field investigations, particularly outside of protected areas, agricultural endeavors at various scales often existed in association with wetlands. Agriculture was commonly observed on the floodplains of rivers such as the Wami, Mkindo, and Diwale (Figure 6) where flood waters provide a regular influx of sediment and nutrients, as well as an opportunity to irrigate or hand water crops. As discussed in the 2007 report (Gritzner and Sumerlin 2007), the disturbance of perennial vegetation along riverbanks leaves them prone to accelerated erosion if there is no bedrock control. This often leads to channel widening or migration, the loss of riparian habitat and/or crop land, and the contribution of sediment within the channel. Excessive sediment can have a negative effect on aquatic habitat, and depending on the magnitude of sediment deposition can contribute to a positive feedback cycle that promotes channel widening, further bank erosion, and increased sedimentation. In the area of Matipwili, this process was observed to be active, and a history of river migration in agricultural areas was described by village elders during interviews (Gritzner and Sumerlin 2007).

In riverine wetlands along the Tami and Divue Rivers, we observed a wide variety of crops are being grown within or adjacent to wetlands to take advantage of organic soils, and high water tables to facilitate production. Here too, the potential for river migration or widening is possible with the disturbance of perennial vegetation on river banks. Although some limited bank erosion was observed, it was not excessive in the areas we were able to access.

There are several other ways for agriculture to affect wetlands. The Tami and Divue Rivers, as well as a number of others, feed a large system of wetlands that compose the Mkata Plain (Figure 6). The Mkata Plain and a slightly detached wetland complex to the northeast consist of a variety of wetland types (riverine, palustrine, and lacustrine), and is widely used both for subsistence agricultural as well as industrial agriculture (Figure 7). At the northeastern extent of this area, industrial agriculture affecting wetland resources includes the cultivation of sugar cane and rice. Here, and in areas of subsistence agriculture, the conversion of wetlands to agricultural land has the potential to detrimentally affect wetland function by decreasing its ability to filter out sediment and other pollutants, as well as attenuating flood waters by removing vegetation. It also directly compromises water quality through the addition of petrochemical agricultural products by direct application and/or runoff to the hydrologic system. Biodiversity is also affected by reducing habitat quantity and quality. An analysis of remotely sensed imagery provided by Google Earth (August 2009) shows relatively intact, contiguous areas of riparian vegetation and/or riverine wetland through the Mkata Plain with distinct areas of land conversion that encroach upon wetlands and rivers for agriculture, especially near population centers.

Figure 7. Wetland agriculture near Divue River.

Mtibwa Sugar Factory and Dakawa Rice Projects have been identified as polluters in the Wami River Basin. Not only have wetland areas been converted to paddies, or water normally stored in wetlands diverted to paddies and fields, but runoff from rice paddies and sugar cane plantations reportedly runs unchecked. Anecdotal reports of an increasing "saltish" taste to water during high flows by downstream users have been reported that may partially be a result of agricultural runoff to the Wami River (Gritzner and Sumerlin 2007). The predominant assemblage of macroinvertebrates shows a moderate to high tolerance of pollution indicating decreased water quality that could in large part be attributed to agriculture (Tamatamah 2007).

The potential for detrimental effects to wetlands and associated impacts to ecosystem services in the Wami River sub-basin continues to grow. Wetlands are identified as potential areas of agricultural growth for subsistence farming under current land tenure systems (Hyera 2007). Although we are uncertain of specific proposed locations, wetlands may be impacted by the proposed sugarcane plantation near Matipwili (Valimba 2007).

Recommendations:

- Delineate wetlands using aerial photography and field techniques throughout the sub-basin
- Compare distribution of wetlands with distribution of agricultural land use/cover
- Assess functioning condition of wetlands in agricultural areas

- Monitor ecosystem services (i.e. water quality, discharge, biodiversity) and compare to reference conditions
- Provide extension services on conservation oriented farming practices (agroforestry), wetland services, and environmental regulations in these areas to agriculturalists
- Enforce established environmental regulations

2.2 Effects of Grazing on Wetlands

Findings and Concerns: The effect of grazing on wetlands and riparian areas has been widely documented (Kauffman et al. 1984). Poorly managed grazing can lead to substantial reductions in vegetation, resulting in a loss of functional capabilities related to the dissipation of high water flow, filtering sediment and pollutants, soil holding capacity and root strength, groundwater recharge, cultural resources, habitat diversity, and biodiversity. The physical trampling of stream banks contributes to sedimentation and a deterioration of aquatic habitat, and can compromise the water retention capacity of a wetland if the retaining layer of a wetland is penetrated.

Concern over the impact of grazing on wetland and riparian areas was expressed by WRBWO personnel. Although grazing is a somewhat ubiquitous land use activity, the majority of rangeland grazing that the team observed took place in the relatively dry areas of the Kinyasungwe River system and Mkata Plain. Riparian areas where the team saw the greatest effects uniquely from grazing were in seasonal reaches of the Kinyasungwe river system (Figure 8). Effects generally included localized bank trampling. Further investigations and aerial photography would likely reveal more heavily impacted sites.

Figure 8. Effects of grazing in the riparian area of the Kinyasungwe River.

Although the team did not directly observe the effects of grazing on wetlands, cattle, goats, and sheep grazing in large numbers in between Kilosa and Morogoro were observed, as well as between Dakawa and Mvomero on the Mkata Plain. In Google Earth (June - August 2009) images, the team was able to identify evidence of livestock trailing through areas of sparse vegetation. Here and in other areas where vegetation is heavily impacted by browsing, the effects discussed above can be expected.

Recommendations:

- Delineate wetlands using aerial photography and field techniques throughout the sub-basin
- Compare distribution of wetlands with distribution of pastoral land use
- Assess functioning condition of wetlands in areas affected by grazing
- Monitor ecosystem services (i.e. water quality, discharge, biodiversity) and compare to reference conditions
- Develop a contingency of stakeholders interested in the conservation of wetlands and mangroves
- Provide extension services to pastoralists on improved grazing strategies, wetland function and environmental services, as well as environmental regulations
- Provide designated watering areas or troughs away from sensitive riparian and wetland areas
- Construct grazing exclosures around priority wetland-riparian areas to allow for recovery

2.3 Effects of Water Abstractions on Wetlands

Findings and Concerns: In discussions with WRBWO officials regarding the results of sample surveys taken on known versus unknown abstraction points of surface water of the Wami River sub-basin, it was determined that less than 25 percent of abstractions are known and managed (pers. comm. 2009). Of the 296 registered abstractions, the majority (176) use groundwater from boreholes or wells, while rivers (99), spring (14), and reservoirs (7) make up the minority of registered water rights (Valimba 2007). Although there are no registered water rights for abstracting water from wetlands, anecdotal information indicates that this does occur (pers. comm. 2009).

Without good information on water use in relation to wetlands (either direct wetland use or upstream use) and monitoring information of wetland parameters, it is difficult to ascertain what ongoing effects water abstraction may be having on wetland resources. The potential effects will vary depending on the type of wetland and whether it receives the majority of its water from rain and surface flow or groundwater flow. The potential for significant water drawdown that would affect the functioning condition of a wetland would be surface water abstractions from a wetland that receives most of its water from rainfall and surface water runoff. In any case, the functioning status of wetlands with

respect to water quantity is based on the relative quantities of recharge and discharge, and what is sufficient to maintain wetland soil and vegetation properties.

The Msagere and Tubilinyi Kwajumbe wetlands in the Zaraninge area are examples of wetlands that are functioning at risk partly because the rate of discharge during the dry season (when there is no recharge) continues beyond the natural rate of infiltration and evaporation as people collect water for watering crops and domestic purposes (Figure 9).

Figure 9. Msagere wetland at residual pool level is being used to water crops in foreground.

Recommendations:

- Monitor recharge and discharge rates of wetlands
- Monitor water abstraction in relation to wetlands
- Assess functioning condition of wetlands in areas affected by water abstraction
- Provide extension services to water users on wetland function, environmental services and environmental regulations
- Enforce established environmental regulations

2.4 Effects of Industry and Infrastructure on Wetlands

Findings and Concerns: The industrial use and effects to wetlands occurs in the central and eastern parts of the Wami River sub-basin. In the central part of the sub-basin, the

industrial use of wetlands is agriculture (discussed above). This includes the Mtibwa Sugar Factory and Dakawa Rice Projects, as well as potential indirect effects from runoff from sisal plantations. Effects here are a result of the conversion of wetlands to agricultural uses, effluent contaminating surface water, and the abstraction of water from wetlands. The specific effects are discussed above.

Another observed use of historic wetland areas to support industry was the draining of wetlands to make way for large building projects and housing developments. One example of this was seen in the Morogoro area where ditches were excavated through a wetland to create a warehouse and office for train parts (Figure 10). Ditching wetlands, in this case, allows water retained in the soil to drain away from the area, effectively lowering the water table enough to provide firm ground on which to build and to reduce the risk of flooding during wet periods. With a depressed water table, obligate and facultative wetland plant species assemblages typically shift to a more upland assemblage. During this transition an increased component of noxious weeds often occurs. The biological effect of this transition can have negative effects on livelihood strategies that depend on wetland ecosystems as well as overall biodiversity.

Figure 10. Wetland drained for installation of infrastructure.

In the lower, eastern part of the sub-basin, near the Wami River estuary, industrial salt production is making use of an inter-tidal zone and mangrove wetland to feed salt manufacturing infrastructure (Figure 11). To create this infrastructure, native mangrove vegetation is removed and large pools are excavated to regulate and retain sea water from high tides. Mangroves are important for a number of reasons. The physical services they perform in coastal and estuarine areas include trapping sediment and nutrients from freshwater runoff and tidal activity, providing shoreline stability, and protecting inland areas from high wave events (e.g. tsunamis) and storm surges. Mangroves are also very important to biodiversity, as nutrients retained in mangroves are distributed through tidal

activity and sustain huge populations of invertebrates. These organisms feed a wide range of birds, fish, shrimp and other animals.

Figure 11. Salt works near Wami River estuary.

Besides the salt industry, livelihood strategies that rely on mangroves in this area include wood gathering – primarily for charcoal production. The detrimental effect of historic and ongoing use of mangroves for this purpose is recognized and efforts have been made to curb the cutting of trees from this unique ecosystem. The fishing industry is another local livelihood strategy whose viability is connected to the health of mangroves (Figure12). Prawn fishing historically has been a leading component of the local economy (Anderson et al. 2007). For more than six years, there has been a reported decline in the prawn catch. The effects from lost mangrove forests may contribute to the decline in prawn (and other) fisheries.

Figure 12. Fish catch at Saadani fish camp on Wami River (Gritzner and Sumerlin 2007).

Recommendations:

- Delineate wetlands and mangroves using aerial photos and field techniques
- Monitor extent and distribution of wetlands and mangroves
- Establish and monitor the functioning condition of wetlands and mangroves in areas prone to the effects of industrialization
- Develop a contingency of stakeholders interested in the conservation of wetlands and mangroves
- Provide extension services on wetland/mangrove function and environmental services, as well as environmental regulations
- Explore alternative fuel sources and/or cooking technology
- Continue to enforce established environmental regulations

2.5 The Effect of Cultural Use of Wetlands

Findings and Concerns: The use of wetlands for cultural purposes in the Wami River sub-basin is widespread (Figure13). In discussions with members of the workshop, cultural uses of wetlands included:

- water extraction for domestic and agro-pastoral purposes
- crop production
- clothes washing
- woody plants for building materials

- plant fibers for baskets, mats, roofing material, etc.
- plants for medicines
- food gathering
- hunting
- fishing
- clay for brick building

Figure 13. Clothes washing in riverine wetland of the Divue River.

Our observations of the cultural use of wetlands and the resulting effects of their uses varied widely with the type and intensity of use. In areas where limited extraction of water and biological components of wetlands occurs, the effect to functioning condition was negligible and use would be considered sustainable. However, in areas of relatively high population density, the pressure on wetland resources can compromise function to varying degrees. This is also true of methods of extraction.

The use of poisons was reported as a means of extracting fish from wetlands. Besides the indiscriminant killing of fish that threatens the viability of future populations, these poisons were also reported to be effective at killing amphibians and other aquatic species. There are also obvious implications for water quality and health issues for organisms drinking poisoned water. Additionally, a wetland ecosystem that lacks a healthy population of fish and amphibian species is more likely to breed large populations of mosquitoes and other insects that are vectors of disease. Malaria has been identified as one of the greatest threats to human health in this part of Africa. It also weakens or

removes a critical source of food to higher trophic levels of the food chain and compromises the overall integrity of the biological community.

Another cultural use of wetlands that was widely observed was the extraction of clays for brick building (Figures 5 and 14). Because of the anaerobic condition of wetland soils, clay is a byproduct of the reduction of iron. Therefore, wetlands are a natural source for clay in the manufacturing of bricks. In order for wetlands to function properly, water needs to be retained long enough to create anaerobic soil conditions and support obligate and/or facultative wetland plant species. This sometimes requires the water retaining layer that clays provide to prevent rapid infiltration.

Figure 14. Clay soils used for brick production near the Msanvu Nzambarnuni wetland in Morogoro.

In wetland areas where clays are being extracted for brick manufacturing, dredging activities affect the functioning condition of wetlands by removing vegetation and changing or eliminating the water retaining/holding capacity. The functioning condition of wetlands used for this purpose is greatly compromised (functioning at risk) or rendered non-functional.

Recommendations:

- Delineate wetlands using aerial photography and field methods
- Document wetland use and distribution of use
- For uses that negatively affect wetland resources or function, explore alternative use, means of extraction, or materials
- Develop a contingency of stakeholders interested in the conservation of wetlands and mangroves

- Develop conservation strategies that are prioritized and adapted to wetland function and issues of use
- Provide extension services on wetland function and environmental services, as well as environmental regulations
- Provide extension of sustainable wetland use
- Explore alternative livelihood strategies in areas where wetland use is impacting function
- Continue to enforce established environmental regulations

2.6 Jurisdictional Overlap and Agency Communications

Findings and Concerns: In various conversations during the course of this mission, it was made clear that wetland resources and their condition is an interest shared by a number of governmental and non-governmental organizations. As an example, in the Wami River sub-basin, the WRBWO is concerned with aspects of flow, abstractions and water quality. The Ministry of Natural Resources and Tourism (MNRT) is more concerned with wetlands as an entity and their value to landscapes, ecosystems, and wildlife. There were several other examples of agencies whose management jurisdiction included wetland resources in some manner.

During discussions at the workshop with personnel from MNRT and WRBWO, ongoing activities and planning for the management of wetland resources were discussed. It became apparent that aspects of these activities, which have the potential to affect management, had not been previously discussed between the agencies. In one case, we conferred on how upcoming efforts by MNRT to classify, monitor, and evaluate wetlands without other agency input could potentially create a gap in how wetlands are defined, how agencies communicate about wetlands, and could compromise future inter-agency understanding of management agendas and potential for cooperation. It also risks duplicating efforts already undertaken by other agencies.

Course participants pointed out that agencies may authorize and carry out activities in wetlands that coincide and, sometimes, conflict with those of other agencies. For example, large quantities of water are diverted from rivers into commercial agricultural schemes, reservoirs for hydroelectric dams, and for community water systems upriver of small traditional irrigated farms and some of the country's national parks. The end result oftentimes is a loss of crop production and diminished habitat in national parks (Franks et al. 2004, Rose 2008). Both agriculture and, increasingly, tourism are important to the economic wellbeing of Tanzanians (Fitzpatrick 2008).

In our discussions, we learned that the Wildlife Division in the Ministry of Natural Resources and Tourism (MNRT) is the lead agency in managing wetlands with a management agenda of "wise use." However, two groups are charged by the government to coordinate administrative and scientific aspects of wetland management in Tanzania. The National Wetlands Steering Committee (NAWESCO) provides administrative oversight and has representatives from eight government ministries and government offices. The National Wetlands Working Group (NWWG) provides scientific oversight,

and is comprised of 30 wetland stakeholders. Both groups are referenced frequently in documents pertaining to the use and management of wetlands in Tanzania (Danida 2003, IUCN 2008). While our team did not have an opportunity to investigate what specific resources and assistance these groups may be able offer TCMP and WRBWO in their objectives for understanding and managing wetlands in the Wami River sub-basin, it does provide a context in which to explore constructive communication and collaboration, and may provide some clarity to jurisdictional function.

Recommendations:

- Determine from NAWESCO what information is available on the status of wetland management in Tanzania
- Clarify from NWWG the status of wetland classification, inventory and monitoring in Tanzania and what accepted tools are used and/or available to classify, inventory and monitor wetlands
- Depending on the administrative and technical status of NAWESCO and NWWG, determine how that can help standardize wetland management in the Wami-Ruvu Basin
- Ascertain the status of the national Sustainable Wetland Management initiative and how it can benefit activities in the Wami-Ruvu Basin

2.7 Lack of Enforcement of Existing Environmental Regulations

Findings and Concerns: There were several aspects of land use which were identified as threats to wetland resources during our team's investigations. In exploring the realm of possibilities for mitigating some of these issues, discussion frequently turned to environmental regulations.

Tanzania has undertaken a number of reforms to proactively address challenges in managing water resources. Major reforms in water policy include: the National Rural Water Supply Programme (1985); the First National Water Policy (1991); the Water Sector Review (1993); the Rapid Water resources Assessment (1994); and the River Basin Management and Small Holder Irrigation Improvement Project (1991), which was revised with others to become the new National Water Policy (NAWAPO), approved by the cabinet in 2002 (EFA, 2008). NAWAPO reserves sufficient water to protect the environment as the second highest priority for water use - behind human use (EFA, 2008). Course participants also cited the National Environmental Management Act established 2004 (NEMC 2009, World Bank 2009) that provides the guidance for protection of the environment including wetlands.

Although adequate environmental regulations are in place to protect water resources, including wetlands, the capacity for various agencies to uphold environmental regulations was cited as an ongoing challenge. This is true both from the point of view of agencies lacking the resources to enforce laws, as well as a reasonable array of alternatives to present land and water users whose use is compromising the proper functioning condition of watershed and wetland resources. Workshop participants also pointed out that there is

a general lack of understanding of environmental regulations among the general population of land and water users in the Wami River sub-basin.

Without some capacity for the enforcement of existing environmental regulations and the education of the general population regarding some of the more relevant points of these regulations, issues of water resource degradation are likely to persist. This will also be a fundamental stumbling block in gaining a foothold for any new conservation initiatives.

Recommendations:

- Develop a clear understanding of which agency's jurisdictional area enforces environmental regulations that provide for the protection of wetland resources
- Identify and provide necessary resources to agency(s) to uphold national environmental law
- Provide extension and educational opportunities to people who may be affected by environmental regulations
- Continue to explore possibilities for alternative livelihood strategies that are adapted to the socioeconomic needs of people affecting wetland resources
- Develop a collaborative conservation initiative in the Wami River Sub-basin that clearly defines a purpose and need for conservation/restoration and prioritizes goals and geographic areas

2.8 Delineation and Classification of Wetlands

Findings and Concerns: As discussed earlier in the report, a clear understanding of the extent, location, and type of wetlands is critical to understanding the overall hydrologic function of the greater sub-basin; how and where land-use issues may be affecting wetland and water resources; and defining the scope of conservation initiatives. In our visit to the Wami-Ruvu Basin Water Office in Morogoro, we were presented with a GIS depiction of the current level of wetland delineation. In general, areas delineated as wetlands were fairly gross in scale and lacked the metadata to track the origin of delineation. Drawing upon discussions with WRBWO Engineer Misigalo Kigadye, our assumption is that delineations were generated from small scale maps such as the 1:2,000,000 pictured below (Figure 15). We also discovered in field investigations that areas delineated and classified as wetlands such as the area bordering the highway east of the town of Pandambili did not fit conventional definitions or function of a wetland (Figures 15 and 16). Currently, the area is a shallow ephemeral wash, connected under the highway by a small culvert (Figure 16).

It is unclear if a specific system for the classification of wetlands in Tanzania is established. In a paper by Mwanukuzi (date unknown), he states that wetlands in Tanzania are classified according to the physiography and environment in which they exist according to Ramsar convention. Elsewhere, wetlands are referred to using the Cowardin classification system which classifies wetlands based on hydrology and plant assemblages (Valimba, 2007). There is a wide variety of classification systems in use today. Different classification systems will subdivide wetland types using different parameters. This gives rise to issues where terms commonly used to refer to wetlands (i.e.

marshes, swamps, bogs) may be given somewhat different definitions under different classification systems. And, because terms are defined within a classification system, they can be descriptive of how the wetland functions (i.e. rain-fed versus groundwater-fed) which may have implications for management. As discussed earlier, a common classification system is important for establishing a common language and understanding among managers with a common goal.

During the workshop, the team presented elements of wetland delineation and classification, and discussed the relevance of this subject in relation to current wetland management efforts. A lack of basic tools such as aerial photography and well understood methodologies of inventory and monitoring were identified as a common impediment to progress in this respect. A lack of a well understood and common classification system designed for the conditions and management needs in Tanzania was also identified as an issue.

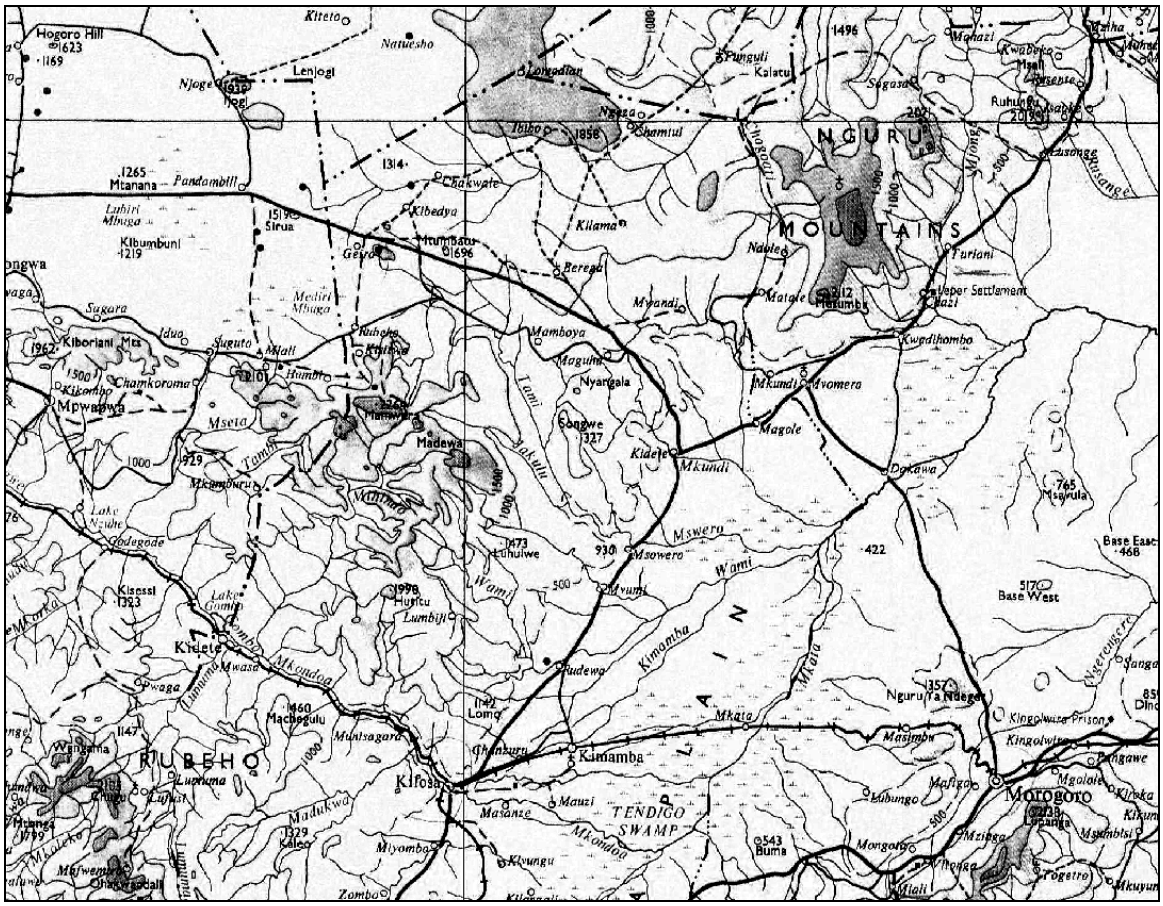

Figure 15. Example of GIS imagery available at WRBWO. Displayed are the roads, hydrology and topography layers. The symbology commonly used to denote wet areas (i.e., surrounding Tendigo Swamp) were likely used for wetland delineation.

Recommendations:

- Provide intensive training for professionals and technicians tasked with wetland delineation. Training should include aerial photography interpretation, and field techniques
- Acquire the tools necessary to perform wetland delineation
- Acquire and use recent GIS data layers to help determine the potential locations and extent of wetlands before going to the field. At a minimum, GIS data layers that should be used include vegetation, soils, hydrology, topography and land cover
- Generate updated wetlands hydrography layer to use in GIS analyses
- Collaborate with stakeholders to identify a common classification system for wetlands

Figure16. Area assumed to be a wetland in the WRBWO GIS, located just east of the town of Pandambili on Route B129 (see map in Figure 6). The area is used by a farmer for dry-season gardening.

2.9 Lack of Readily Available Aerial Photography

Findings and Concerns: The issue of a lack of readily available aerial photography is a persistent problem in the Wami River sub-basin (Gritzner and Sumerlin 2007). Neither the WRBWO nor TCMP had access to recent aerial images of the areas visited. We discovered this to be a common problem among resource managers in the area. Not having access to aerial photography greatly limited the team's ability to assess wetlands in the sub-basin during the period of our mission.

Aerial photographs and instruments to interpret them are essential tools to plan, conduct field work, and finalize successful campaigns of wetland delineation and plant inventory and analysis. Recent aerial images, acquired at the appropriate scale for wetland assessments can save a great deal of time and money compared to on-the-ground determination of location and extent of areas to be assessed.

The USACOE (1987) recommends using color infrared imagery at a scale of 1:24,000 for surveying vegetation. Recent aerial photography, particularly color infrared, provides a detailed view of an area and highlights changes in vegetation. Thus, aerial extent of land use and/or plant communities, and therefore the degree of inundation of the area when the photography was taken, can be determined.

Recommendations:

- Acquire recent geo-referenced aerial photography to assist with locating and determining the locations and extent of wetlands in the Wami River sub-basin
- Inquire about the availability of recent imagery through other agencies, universities and organizations
- If no imagery is currently available, work with stakeholders to share the cost of acquiring imagery, or acquire funding through granting agencies
- Make acquisition of photographs widely available to resource managers

2.10 Need for Intensive Technical Training for Wetland Inventory and Monitoring

Findings and Concerns: Wetland training was identified in the terms of reference for this mission as contributing to and strengthening the FY2009 USAID Tanzania-SUCCESS program of work under the landscape to seascape initiative, and as a way to build capacity of the WRBWO and other cooperating agencies. The three-day training session that was developed for this mission was tailored to provide an overview of wetlands, some of the related issues associated with managing wetlands, introduce inventory and monitoring protocol, and to begin working with a riparian-wetland assessment methodology. Participants indicated that the material presented was very useful to them. It should be noted, however, that the level of understanding required to accurately assess the form and function of wetlands is normally developed over an extended period of time. A general survey of participants indicated a relatively low level of direct involvement with wetlands in their current positions.

Because obtaining accurate information is so important to the success of an inventory and monitoring program, a well trained staff with developed wetland inventory and monitoring skills is needed to assist the WRBWO and other cooperating agencies in delineating and assessing the status of wetlands in the Wami basin.

Recommendations:

- Identify a full-time wetland resource specialist to lead wetland assessment and monitoring program for WRBWO and/or other cooperating agencies such as MNRT.
- Arrange for the training of current employees in the skills needed to conduct wetland inventories and monitoring, and/or hire additional staff accordingly to provide for long term, internal skill sets
- Seek out and provide mentoring opportunities for staff involved in wetlands management
- Seek out and provide additional educational opportunities for staff involved in wetlands management

2.11 Need for Centralized Data Warehouse and Steward

Findings and Concerns: Information and data on the locations, extent, and status of wetlands in the Wami basin are limited. The WRBWO has limited information in the form of a GIS layer for wetlands, but no metadata were found for the layer. Without this information the layers and information on them are of limited use. Field investigations also revealed inaccuracies in extent and classification of the land-type.

Other information and data relevant to wetland resources in the Wami River may reside in disparate locations with agencies, NGOs, universities, or individuals overseas. Presently, there is no person, government agency, nor NGO that is actively collecting and coordinating information related to wetlands. As a consequence, information required for the identification of trends in resource condition, and for making informed management decisions is lacking.

Recommendations:

- Design and implement an inventory and monitoring program for wetlands that will generate data regarding changes in extent, function, and condition
- Obtain or create metadata when acquiring or generating GIS coverages/layers. At a minimum this should include the coordinate system, datum, projection, and personal contact for future reference
- Offer opportunities for employees to receive training in GIS data acquisition and management.
- Develop and maintain a centralized data warehouse for natural resources data
- Establish a single agency or entity tasked with actively seeking out and compiling existing data and managing the central data and information repository
- Employ the services of a data steward.

Table 1: Summary of Recommendations

Recommendation	Time Frame	Responsible Agency
Obtain recent, georeferenced aerial photography of the Wami River sub-basin	As soon as possible	Inter-agency effort
Delineate wetlands within the Wami River sub-basin using aerial photography and field techniques.	Begin as soon as possible. Will be an ongoing effort.	MNRT, WRBWO, SANAPA
Assess functioning condition of wetlands	Begin as soon as possible. Will be an ongoing effort.	MNRT, WRBWO
Map threats to and uses of wetlands	Begin as soon as possible. Will be an ongoing effort.	MNRT, WRBWO
Prioritize wetlands for monitoring and begin monitoring program.	Begin as soon as possible. Will be an ongoing effort.	MNRT, WRBWO Technical assistance/training from USFS
Develop a contingency of stakeholder interested in the conservation of wetlands	Begin as soon as possible.	MNRT, WRBWO
Identify agencies to provide extension services for wetland conservation, and relevant environmental regulations	Begin as soon as possible. Will be an ongoing effort.	MNRT, WRBWO, TCMP
Develop a conservation strategy for wetlands (i.e. restoration, mitigation, extension, alternative use, sustainable use, etc.)	1-2 years	All stakeholders
Enforce established environmental regulations	Ongoing	MNRT, WRBWO

3. WORKSHOP OVERVIEW

The US Forest Service team conducted a 3-day wetlands workshop from June 25 – 27, 2009, in Morogoro (see Appendix C for an overview of course content). The workshop included an introduction to wetlands and various wetland-riparian topics, an introduction to inventory and monitoring protocol, and a focused review and application of the Proper Functioning Condition (PFC) protocol for lentic and lotic systems (BLM 2003, and BLM 1998). The format of the workshop was 2 days of classroom sessions, held in meeting facilities at the Nujoasha Hotel, arranged for by the Wami-Ruvu Basin Water Office. The 3rd day was in the field, applying the assessment protocol to several wetland and riparian sites in the Morogoro area to give course participants the opportunity to serve on an

assessment team and experience firsthand how the Proper Function Condition (PFC) methods for lentic and lotic systems are used. The afternoon session on the 3rd day was used to respond to questions and feedback from participants on the materials that had been presented in addition to any other observations and comments participants had. The team received positive feedback from participants on course content and the potential usefulness of the PFC protocol.

The PFC protocol was chosen to present at this workshop because it provides a consistent approach for considering hydrology, vegetation, and erosion/deposition (soils) attributes and processes to assess the condition of wetland-riparian areas (BLM, 1998). It is a qualitative approach to assessing the properly functioning condition of a wetland-riparian area that employs an interdisciplinary team of specialists to synthesize information and reach conclusions on how well physical processes are functioning. This methodology has proven to be an effective tool in bringing diverse groups to consensus and provides a common language for defining desired future conditions and resulting values (BLM 2002). Assessing the functioning condition of a wetland-riparian area is also a critical first step to stratifying sites for monitoring.

Participants were provided copies of PFC manuals for lotic and lentic systems as well as a CD which contains all of the PowerPoint presentations used during the training (Appendix F). Also included on the CDs are a variety of references in PDF format (including PFC manuals and assessment forms) and links to internet sites that the training team thought would be useful to course participants. Additional copies of the CDs can be obtained by contacting Sandy Nundwe (fourth from the right – Figure 17) at the TCMP office in Dar es Salaam. Sandy's contact information is included on the Workshop Participants list (Appendix D).

Figure 17. Participants at USFS–WRBWO Wetlands Workshop in Morogoro, Tanzania, June 25-27, 2009. Not all participants are pictured.

4. POTENTIAL FUTURE ROLE FOR USFS TECHNICAL ASSISTANCE

1. Provide assistance in preparing and implementing plans for inventory and monitoring of wetlands and other watershed resources.

2. Provide further focused training to natural resources professionals and/or technicians in inventory and monitoring techniques.

3. Provide input on the design and implementation of mitigation measures to address threats in the Wami-Ruvu River sub-basin.

4. Conduct any further pointed resource assessment of watershed resources to evaluate resource conditions, unidentified threats, potential mitigation measures, and provide recommendations for future mitigation.

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APPENDIX A -- MISSION ITINERARY

Friday, June 12: USFS Team (Jason Gritzner and Roy Jemison) depart from home and travel to Dar Es Salaam via Amsterdam and Kilimanjaro.

Saturday, June 13: USFS team arrives in Dar Es Salaam late in the evening and travels to the hotel.

Sunday, June 14: USFS team reviews work plans, agendas, resources, and prepares for mission.

Monday, June 15: USFS team meets with Appa Mandari of TCMP at the TCMP office to review mission itinerary and discuss some of the objectives and logistics of the mission. The team then travels to the USAID office to brief Gilbert Kajuna (Deputy Team Leader of the Natural Resources Management Program), and Asukile Kajuni (Senior Environmental Management Specialist) on the mission objectives and itinerary. The team travels to Morogoro with Jacob Mlula (TCMP driver) and meets with Julius Sarmett (WRBWO Director) and a hydrologist of WRBWO in the evening to discuss expectations, objectives and logistics of the both the field portion of the mission and the workshop.

Tuesday, June 16: USFS team visits WRBWO and gets an overview of the office's function, and is briefed on the state of knowledge of wetland resources in the Wami River sub-basin by Misigoro Kigadye. The team meets with Julius Sarmett, then embarks with Misigoro Kigadye and Jacob Mlula on the field investigation portion of the mission. The team visits the Wami River at Dakawa (station 1G1) to look at riparian conditions and possible riverine wetlands, and Pandambiri on the way to Mpwapwa where they stay the night.

Wednesday, June 17: USFS team visits areas identified as wetlands in the area of Mpwapwa, and Gode Gode. The team visits the parts of the Kinyasungwe River and its tributaries, including a fairly large riverine wetland in the Gode Gode area. Many of the areas visited are dry washes. The team visits some of the riverine wetlands along the Tami River, and crosses the Mkata Plain (a large wetland complex) at night on the way back to Morogoro.

Thursday, June 18: USFS team travels north toward the Nguru Mountains to look at wetlands in that area. The team visits Dihombo where presumably palustrine wetlands are being used and/or created to cultivate rice; the riparian area of the Mkindo River; the Divue River riverine wetland complex that supports papyrus and other natural wetland vegetation as well as various forms of agriculture; and the riparian area of the Diwale River downstream of the WFBWO gauging station. The team returns to Morogoro.

Friday, June 19: USFS team travels with Misigoro Kigadye and Jacob Mlula to Saadani National Park to look at coastal wetland systems. On the way to the park the team stops by the Chalinze water pumping plant on the Wami River. Upon arrival at the park, the

team meets with Angela Nyanki (Tourism Warden) at the Saadani Ranger Station in the village of Saadani. The team travels north to the park headquarters in Mkwaja to collect Halima Kiwango (Park Ecologist), and to map and visit lacustrine wetlands near the park headquarters that were built to retain water to provide drinking water to what was previously the Mkwaja Ranch headquarters (now the Park headquarters), as well as other wetlands north of the village of Saadani – including wetlands created entirely or in part by roads interrupting surface and subsurface flow.

Saturday, June 20: USFS team travels to the Zaraninge area and Matipwili with Halima Kiwango, Misigoro Kigadye and Jacob Mlula to map and investigate wetlands. This was an opportunity for a return trip to some wetlands for reassessment. The team visits Lake Kiwandi (also referred to on this trip as Kiwandi Swamp), Msagere and Tubilinyi Kwajumbe wetlands which were all seen in 2007. Water levels in Kiwandi were down from the 2007 investigation, partially as a result of seasonal influences, as well as prolonged drought conditions, but the condition of vegetation did not show any marked change in extent or function of the wetland. Msagere and Tubilinyi Kwajumbe wetlands also had depressed water levels. Here water levels are also influenced by water use during periods when the road-ponded wetlands are at residual levels. Changes in vegetation were noticed in limited areas where adjacent land-cover was converted to agriculture. The team also visits the Kigurukundo wetland, a lacustrine wetland formed by an oxbow of the Wami River, and riparian areas of the Wami River in the vicinity of Matipwili.

Sunday, June 21: USFS team examines wetlands along the tidal fringe of the Saadani area, as well as depressional palustrine wetlands within the village of Saadani. The team then travels with Halima Kiwango, Misigoro Kigadye and Jacob Mlula to the Wami River and travels upriver to a point just upstream from where the 2007 USFS team conducted a bank transect. Upstream progress is interrupted because of low river levels. Transitions in riparian vegetation from mangrove species to less saline tolerant species are said to be continuing to advance upstream. No drastic transitions were noted. Some disturbance of riparian vegetation was noticed in an area on the south bank where it is presumed a camp is being installed. The team, along with Misigoro Kigadye and Jacob Mlula return to Morogoro.

Monday, June 22: USFS team spends the morning at the WRBWO empowering Misigor Kigadye in the use of GPS technology, downloading waypoints, and demonstrating the interactive use of Google Maps.

June 23rd and 24th: USFS team prepares for workshop.

Thursday, June 25: Day 1 of wetlands workshop. List of attendees is located in Appendix C. USFS team covers topics including introduction to wetlands, wetland classification, wetland delineation, wetland function, uses, threats, and management.

Friday, June 26: Day 2 of wetlands workshop. USFS team covers topics including an introduction to inventory and monitoring assessment, and an introduction to the Proper Functioning Condition (PFC) protocol for lotic and lentic systems.

Saturday, June 27: Day 3 of wetlands workshop. USFS team divides the group of attendees into two teams for a practical field application of PFC protocol. Assessments of a lentic system and a lotic system are completed. USFS team travels back to Dar Es Salaam.

Sunday, June 28: USFS team prepares debrief for USAID.

Monday, June 29: USFS team debriefs USAID and TCMP at the USAID office. Attendees included Asukile Kajuni and Gilbert Kajuna of USAID, Appa Mandari of TCMP, and Don Robadue of URI-CRC. Team returns to TCMP office for further discussions of the projects and to make arrangements for further travels while in country.

Tuesday, June 30 – July 2nd /3rd: USFS team takes annual leave.

July 2nd /3rd: USFS team departs Dar Es Salaam to return home (Jason leaves on the 2nd and Roy on the 3rd).

July 3rd/4th: USFS team arrives home via Amsterdam.

APPENDIX B – SCOPE OF WORK

USDA Forest Service and USAID/Tanzania Partnership

Terms of Reference

Wetlands Delineation and Training Workshop in the Wami-sub Basin

Introduction

USAID supported projects coordinated by the Tanzania-SUCCESS project of the University of Rhode Island/Coastal Resources Center have been working in the Wami River sub-basin since 2006. During this time, a Wami River sub-basin profile was written, a preliminary Environmental Flow Assessment (EFA) was produced, a second wet-weather EFA is scheduled for spring 2009, two assessments of the Wami estuary have been conducted, and an assessment of the linkages among the lower Wami and Saadani National Park was completed. The purpose of this work is to improve the landscape-seascape resource management of the water basin.

These Terms of Reference describe an activity focused on the Wami River sub-basin wetlands and capacity building to be carried out in a partnership of the U.S. Forest Service, Wami-Ruvu Basin Water Office (WRBWO), and the USAID Tanzania-SUCCESS project.

Problem statement

In the Wami River sub-basin wetlands have not been studied in detail. However, they are known to play an important role in regulating the hydrology of the sub-basin, purification of water, habitat for different flora and fauna, control floods and also provide areas for cultivation of crops for food security.

In recent years, wetlands in the Wami River sub-basin have been experiencing degradation due to different human activities. These activities have started affecting the hydrology of the basin thereby affecting the wetland functions. This, if not intervened, poses a threat to the sustainability of the wetlands and hence water resources of the sub-basin.

Wami River sub-basin wetlands

Wetlands are pools of water found in the floodplain of rivers. They vary in size, while some dry up relatively quickly, the larger pools are permanent. Some of the functions of wetlands include regulation of river flows, sediment trap, water filter, and contribute to people's livelihoods.

In the Wami Sub-Basin four types of wetlands are identified. These include:

Riverine system which is the largest wetlands system in sub-basin and comprises mainly rivers and floodplains. Many large rivers in the sub-basin such as the Wami, Mkata and Mkondoa and a few small rivers are perennial while others like the Kinyasungwe as well as many small rivers are ephemeral.

Within the Wami Sub-Basin, floodplains are found along the widest channel sections of the rivers and are of different width depending on the locations. It is commonly observed that, for the same river, some sections expand into floodplains while in others floods are completely missing. The largest riverine swamps are found along the long Mkata-Wami-Diwale reach.

Palustrine include generally all vegetated wetlands from marshes to springs to other forms including lagoons, ponds, pans, swamps and dambos. The Tendingo and Dakawa swamps are the major vegetated wetlands in the Wami sub-basin extending almost the whole length of the inland plain zone. The swamps are perennial and seasonally expand during the rainy season between November and May and shrink during the dry season to the smallest spatial extent in late October.

Estuarine wetlands are found near river mouths and are characterized by mixed origin volumes of water. This type of wetlands system in Wami sub-Basin is found along the coastline of Bagamoyo at Saadani where the Wami River discharges into the Indian Ocean.

Lacustrine wetlands are lakes found in depressions or dammed river channels.

Objectives

The proposed training workshop is intended to contribute to and strengthen the FY2009 USAID Tanzania-SUCCESS program of work under the landscape to seascape initiative and build capacity of the WRBWO.

- Delineate wetlands and their biodiversity in the Wami sub-basin with a focus on palustrine wetlands
- Establish relationship in hydrology of the wetlands and the main Wami River
- Identify wetlands condition and threats
- Build capacities of Wami sub–basin stakeholders in monitoring and sustainable management of wetlands
- Identify options and priorities for improved wetland conservation and sustainable use

Methodology

1) A wetland assessment will be made by a 6-8 day reconnaissance of the Wami River sub-basin. USAID Tanzania-SUCCESS will provide a vehicle and driver. Accompanying the USFS team in the vehicle will be Mr. Florence Mahay (hydrologist) from the WRBWO. Other WRBWO staff

may accompany if the Basin Office is able to provide vehicles. Data of the boundaries of the wetlands will be collected using GPS. Coordinates will be plotted in the WRBWO GIS database to show the boundaries of the wetlands and types of wetlands. Prior to the fieldwork, the USFS team will review existing literature and GIS data on wetlands in the Wami River sub-basin. The wetland assessment will build on the previous work done in the EFA in 2008 and contribute to the continuation of this work in 2009.

2) A three-day training will follow the wetland assessment in a venue to be determined. The training will include a field practicum (if feasible). USAID Tanzania-SUCCESS project with the WRBWO will convene the workshop with participants anticipated from WRBWO, Saadani National Park, Wami Mbiki Conservation Area, District Officials, and local leaders. USFS will design and deliver the training.

Time frame: End of June/beginning of July 2009 (approximately 14 days)

Resources:

Wami River sub-basin EFA technical reports: http://wami.fiu.edu/

Wami River sub-basin Profile:
http://www.crc.uri.edu/download/wami_profile_tagged_final_Nov08.pdf

Wami River sub-basin EFA synthesis:
http://www.crc.uri.edu/download/EFA_Summary_Sept08_final_tagged.pdf

First Wami estuary assessment:
http://www.crc.uri.edu/download/WamiEstuaryReport_March2007.pdf

Second Wami estuary assessment:
http://www.crc.uri.edu/download/Final_August_Estuary_Report.pdf

Wami River and Saadani National Park assessment:
http://www.crc.uri.edu/download/USFS_Wadi_River_Feb2007.pdf

APPENDIX C -- OVERVIEW OF COURSE CONTENT AND FORMAT

Wami River Sub-Basin Wetland Assessment Workshop
June 25-27, 2009
Nujoasha Hotel
Morogoro, Tanzania

3.1 Day 1 (Thursday, June 25)

- Introduction of facilitators and participants
    - Name, affiliation, position/title
    - What do you hope to learn?
    - How do wetlands relate to your current position?
- Introduction to wetlands
    - Definition of wetland - USACOE definition
    - Wetland vegetation
    - Wetland soils
    - Wetland hydrology
    - Definitions of nonwetlands - USACOE definition
    - Where wetlands are found
        - Depressions (large and small)
        - Riparian areas
        - On slopes (Springs/Seeps)
        - Tidal fringe
    - Geologic Controls
        - Confined aquifer
        - Geologic contacts
        - Perched aquifers (including dike impounded)
    - Wetland classifications defined by above attributes
- Wetland classification
    - Different wetland classification systems
    - Substrate/vegetation/morphology/hydrology breakdown
- Wetland delineation
    - Systems and tools
- Wetland functions and values
    - Improve water quality
    - Water storage and dry season release
    - Discharge regulation
    - Flood attenuation
    - Groundwater recharge
    - Nutrient cycling and storage
    - Wildlife (aquatic and terrestrial) habitat
    - Migration corridors
    - Social and economic values
    - Educational and scientific values
- Uses of Wetlands

    - Human
        - Water systems
        - Stock watering
        - Agriculture (local use and diversion)
        - Fishing/hunting
        - Ecotourism
    - Wildlife
        - Habitat niches (cover, nesting, etc.)
        - Watering
        - Forage
- Threats to Wetlands
    - Grazing
    - Agriculture
    - Land conversion
    - Burning
    - Mining
    - Water diversion/draining
    - Vegetation extraction
    - Wildlife disturbance
    - Cultural resources (medicines, building materials, etc.)
- Observations if wetlands in the Wami River Sub Basin
- Management
    - Important to maintain function at some level
    - Identify wetland potential
    - Identify wetland capability
    - Develop consensus among users
        - Identification of users and uses
        - Identification of wetland services that you are/are not willing to give up

3.2 Day 2 (Friday, June 26)

- Review of previous day
- Introduction to Wetland Assessment Protocols
- Proper Functioning Condition (PFC) Protocol
- PFC Concepts
- PFC Assessment Elements (lentic/lotic)
- PFC Exercises (from manuals)
- Open discussion
- Prepared for next day field exercises
    - Formation of teams
    - Materials needed: PFC manuals, pencils

3.3 Day 3 (Saturday, June 27)

- Class divided in 2 teams to perform wetland assessments in the field
- Performed PFC Lentic/Lotic wetland assessments (at field sites)
- Open discussion of classroom and field exercise (at training facility)

- Close out

APPENDIX D – WORKSHOP PARTICIPANTS

Wami River Sub-Basin Wetland Assessment Workshop

June 25- 27, 2009

Morogoro, Tanzania

First Name	Surname	Organization/Office	Email
Hassan	Namkeleja	MNRT Wildlife Division	namkeleja@yahoo.com
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Hashim	Juma	Wami- Mbiki	----------
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APPENDIX E -- WORKSHOP FLIP CHART NOTES

Wami River Sub Basin Wetland Workshop
June 25-27, 2009
Morogoro, Tanzania

Participant Comments Recorded on Flip Charts during Workshop

Concerns:

- Build up of salinity in soils

Benefits of wetlands:

- Purification of waste water
- Production of species of commercial value
- Soil stability
- Erosion control

Uses of wetlands:

- Religious worship
- Protection of cultural resources
- Collection of medicinal plants
- Building materials (clay for bricks)
- Wood for charcoal and building materials
- Resources:

Resource	Renewable under current conditions		
	Renewable	Dependence on other factors	Non Renewable
Thatch	X		
Medicines	X		
Minerals			X
Clay for bricks			X
Fish		X	
Logging		X	
Grazing		X	

Threats from wetlands:

- Breeding areas for insects (i.e. mosquitoes)

Protections for wetlands:

- National Environmental Protection Act
- Wildlife and Wetland Policy No. 278
- Water laws
    - Ministry of Water
    - Ministry of Natural Resources and Tourism
- Enforcement

    - Ministry of Tourism and Natural Resources
        - Wetland inventory manual (being developed contractor)
    - National Environmental Management Council
    - Direction of the Environment
    - Basin Offices
        - 9 offices to be established by 2015
    - Wildlife Department (wetland protection)
    - Environmental Officers in Districts
    - Facilitation Teams in Districts
- Conflicts to protections for wetlands
    - Conflicting regulations
        - Different offset/setback regulations
- Outreach
    - Public schools

Objectives of wetland management (MNRT)

- Wise use of wetland areas

Locations of Wetlands

- 40 percent national parks, reserves and other protected areas
- 60 percent outside protected areas

Wami-Ruvu Basin Water Office functions:

- Water tracking via permit system
    - Receives input from water associations
- Pollution control
- Environmental protection
- Water Users Associations (recently established)

Miscellaneous

- IUCN in 1990 focused on wetlands in Tanzania
- Ruaha National park 20,000 sqkm. (largest national park in Tanzania)
- Comment on wetlands as source of greenhouse gas and carbon sequestration, climate change
- NOAA has provided funding for climate change and carbon sequestration??

APPENDIX F -- WORKSHOP MATERIALS GIVEN TO PARTICIPANTS ON CD

Listed below are materials that were given to workshop course participants

A. PowerPoint Presentation
1. Definitions
2. Introduction to Wetlands
3. Delineation
4. Functions
5. Uses and Threats (General Examples)
6. Wetland Uses and Threats (Tanzanian Examples)
7. Wetland Classification

B. References (full documents in PDF format)
1. Bureau of Land Management
2. Proper Function Condition (PFC)
3. Ritchie (Marc Cole) Suggested Wetland References
4. Saadani National Park
5. US Army Corps of Engineers (USACOE)
6. US Fish and Wildlife Service (USFWS)
7. Wami-Ruvu Basin Water Reports

C. Web Links

APPENDIX G – WAY POINTS OF SITES VISITED

Way Point	Latitude	Longitude	Elev. (m)	Description
1	S6.44707	E37.53322	363.32	Wami River crossing, Route B129 near Dakawa. WRBWO Gage No.
2	S6.08449	E36.68517	1242.67	Seasonally flooded roadside area. Currently used as dry season garden.
3	S6.54112	E36.57391	731.82	Abandoned bridge through flooded wetland, SE of Gode Gode.
6	S6.21782	E36.32660	836.37	WRBWO water level sta. # 1GD16 – Kinyasungwe at Old Dodoma Road Bridge.
7	S6.53539	E37.21747	434.95	Riparian veg. along flowing Tami R. in Lukwatu Plains, SW of Kidete on Route B127
10	S6.26418	E37.53899	372.77	Irrigated rice fields along Route B127, SW of Mvomero.
11	S6.24759	E37.55248	352.35	Riparian veg. along flowing tributary to Wami R., NE of Knadihombo on Route B127.
12	S6.21263	E37.57751	356.92	Tributary to Wami R. NE of Knadihombo on route B127.
13	S6.17677	E37.58385	354.18	Bridge over tributary to Wami R. NE of Knadihombo on Route B127.
14	S6.17386	E37.58406	356.92	Cascade above bridge on tributary to Wami R. NE of Knadhombo on Route B127
15	S6.14409	E37.59609	372.16	Low water road crossing major tributary to Wami R. NE of Turiani on Route B127.
20	S6.24675	E38.38712	78.33	Bridge crossing over Wami R. on Route A14 Msata and Mbwewe
33	S5.72868	E38.80270	60.66	Reservoir near Saadani NP Headquarters
34	S6.13683	E38.60736	264.87	Large wet meadow near camp site in Saadani NP (repeat visit)
37	S6.19264	E38.65222	184.10	Msagere wetland in Zaraninge Forest
41	S6.25185	E38.68626	13.72	Matipwili – Oxbow lakes and wetlands
44	S6.23993	E38.71069	13.72	Matipwili – Oxbow lakes and wetlands
46	S6.14187	E38.80469	2.44	Wami River estuary
046-BO	S6.12997	E38.81301	10.36	Wami River – Boat dock
48	S6.14948	E38.80150	1.22	Wami River – up river